EaglePicher™
Filtration & Minerals

Lanthanum Enhanced DE Nanocrystalline Media (NXT)

10/19/04

Agenda

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- Who is EP?
- What is NXT Media?
- Benefits
  - Technical Data Sustaining Results
  - How is it Made?
- Testing History
  - Laboratory
  - Fernley, NV Pilot Test Results
- NXT Adsorption Media Update

Who is EaglePicher?

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- Leading Supplier of DE with Over 60 Years of Experience in the Filtration of Food Grade Products
- Common Applications:
  - Soft drinks
  - Fruit juices
  - Beer and Wine
  - Animals and Vegetable Oils
  - Sweeteners
- Customers:
  - Cargill
  - Tate & Lyle
  - SAB (Miller)
  - Pepsi Co.
  - Welchs

Making Use of the Best Available Technologies

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- Coagulation / Filtration: NXT Precoat Media
  - Pilot tested in Fernley Nevada using Precoat Pressure Filter
  - Further Testing on Rotary Vacuum Precoat Filtration Demonstrated Improved Economics over Pressure Filter by $.03/1000 gallons
    - $0.30-0.40/1000 gallons treated
- Adsorption: NXT Adsorption Media
  - Currently in Final Stages of Development
  - Modified Precoat Media
  - RCSST Testing in Process
- Ion Exchange
- Reverse Osmosis

NXT Media: What is it?

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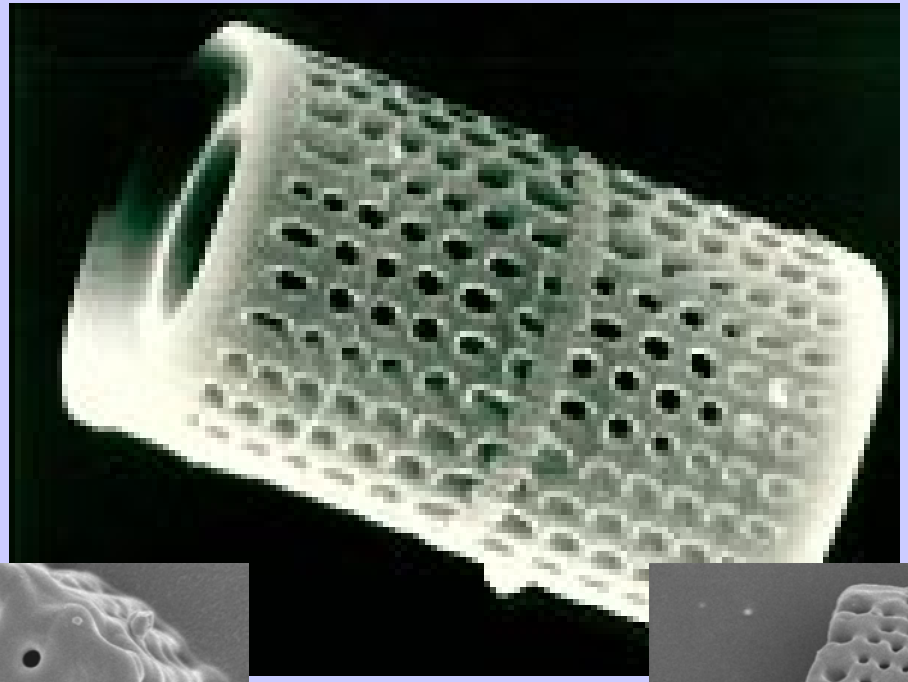
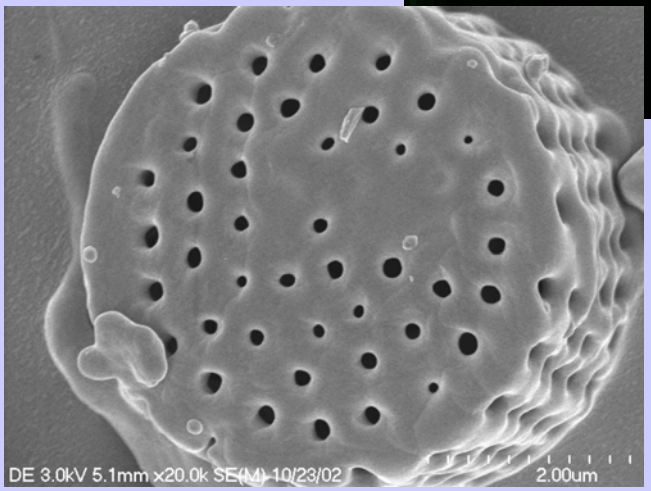
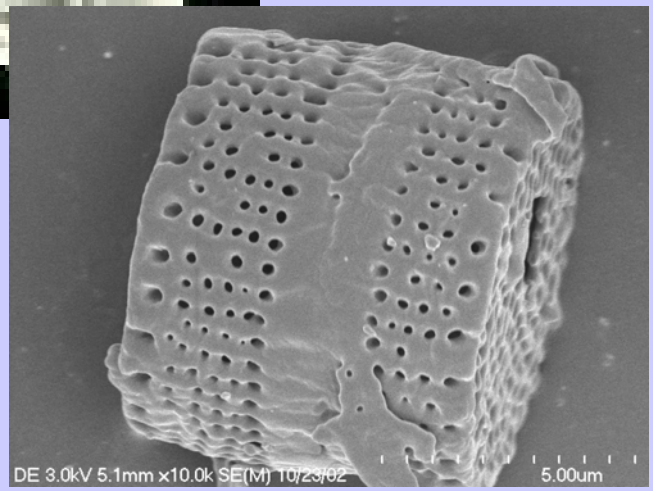
Naturally occurring diatomaceous earth (DE)



DE is a mineral of organic origin. It represents the accumulation of many different kinds of fossils.



La/Fe Coated DE



Characteristics of NXT Media

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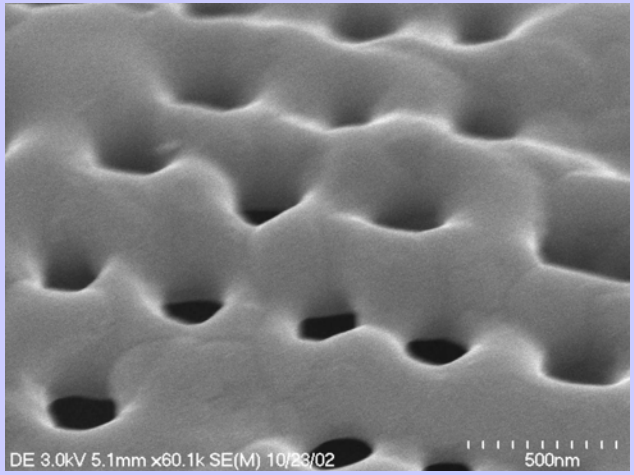
- Surface area of the coated material is estimated to be 100 m2/gm
- Factors for efficient removal of arsenic from water:
  - High surface area
  - Positive surface charge (up to pH 10.0)
  - Inter-particle filtration behavior of DE



- The crystalline nature of precipitate and strong bonding between the adsorbent and arsenic species allow the arsenic to be tenaciously bonded to the materials.

NXT Benefits

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- Cost Efficiency
  - Effective over wide pH range
  - Not selective of state, removes oxidation step
- Safe
  - Will not release bound arsenic if pH upset occurs
  - Spent cake meets TCLP and Cal wet test requirements for non-hazardous material*
- Versatile
  - Removes more than arsenic, phosphates, chromium, selenium and pathogens*
- Stability
  - Long Shelf Life

Effective over a Wide Range of pH

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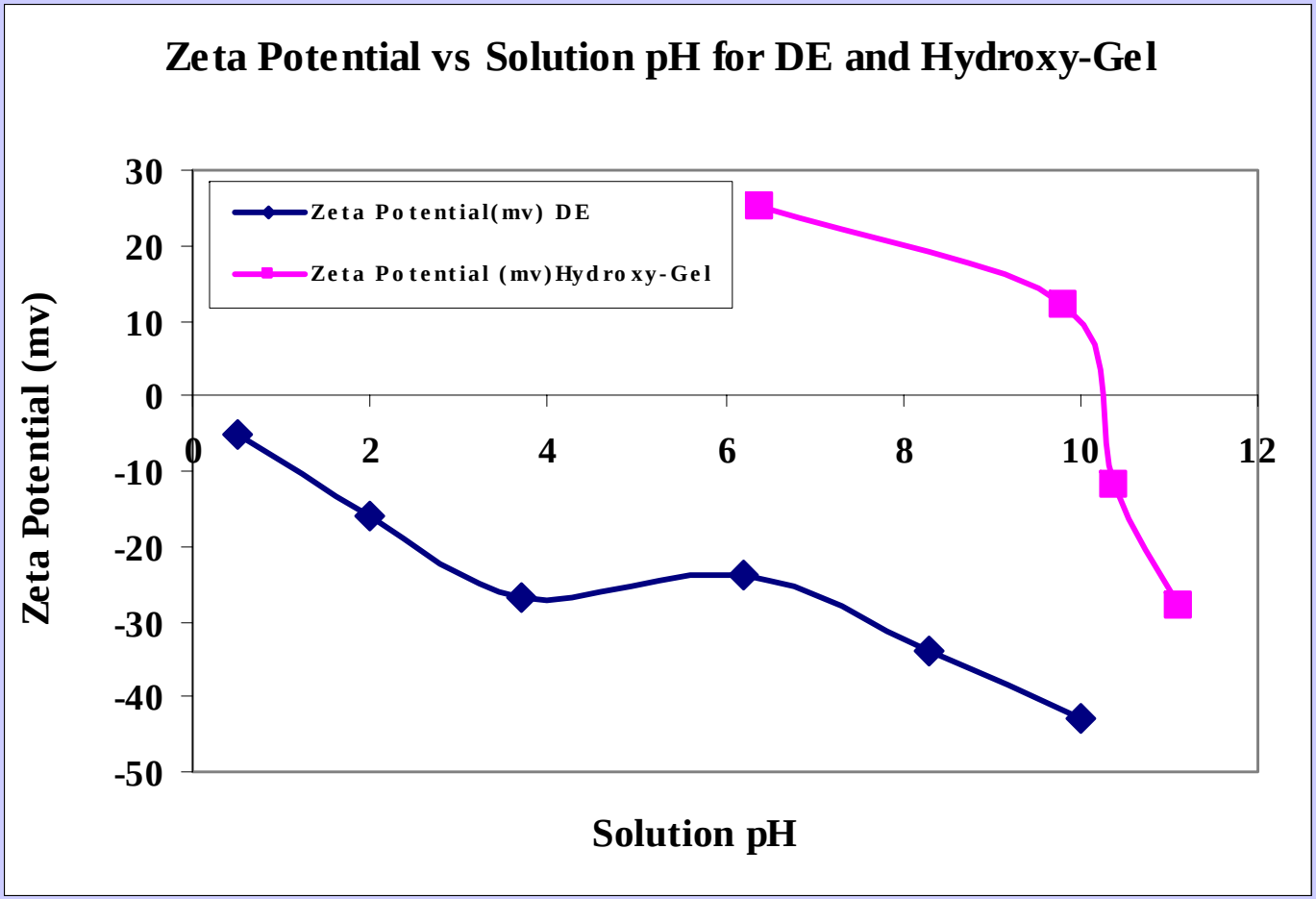

Zeta Potential of DE and Hydroxy-gel

Why La-Fe-Arsenate is Better?

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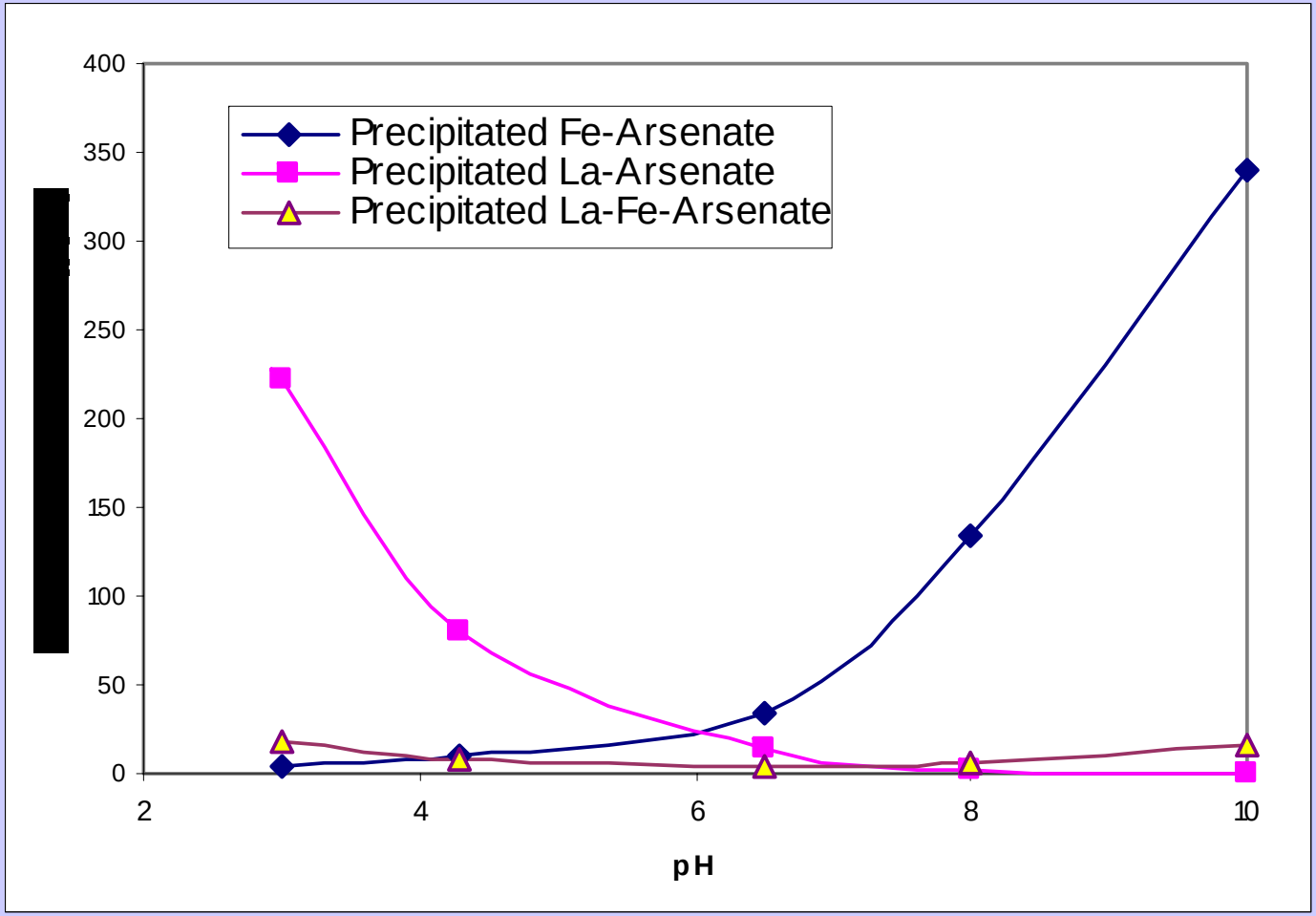

Stability of Precipitated Lanthanum Arsenate / Ferric Arsenate as a Function of pH

Why pH is Important

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In natural waters arsenic is found as Arsenite [As(III)] and Arsenate [As(V)].

Arsenite (As^{+3})	**Arsenate (As^{+5})**
H_3AsO_3 (pH 7 to 8)	H_3AsO_4 (pH <2)
$H_2AsO_3^-$ (pH 10 to 11)	$H_2AsO_4^-$ (pH 3 to 6)
$HAsO_3^{-2}$ (pH 12 to 13)	$HAsO_4^{-2}$ (pH 8 to 10)
	AsO_4^{-3} (pH >12)

Arsenite Species Distribution

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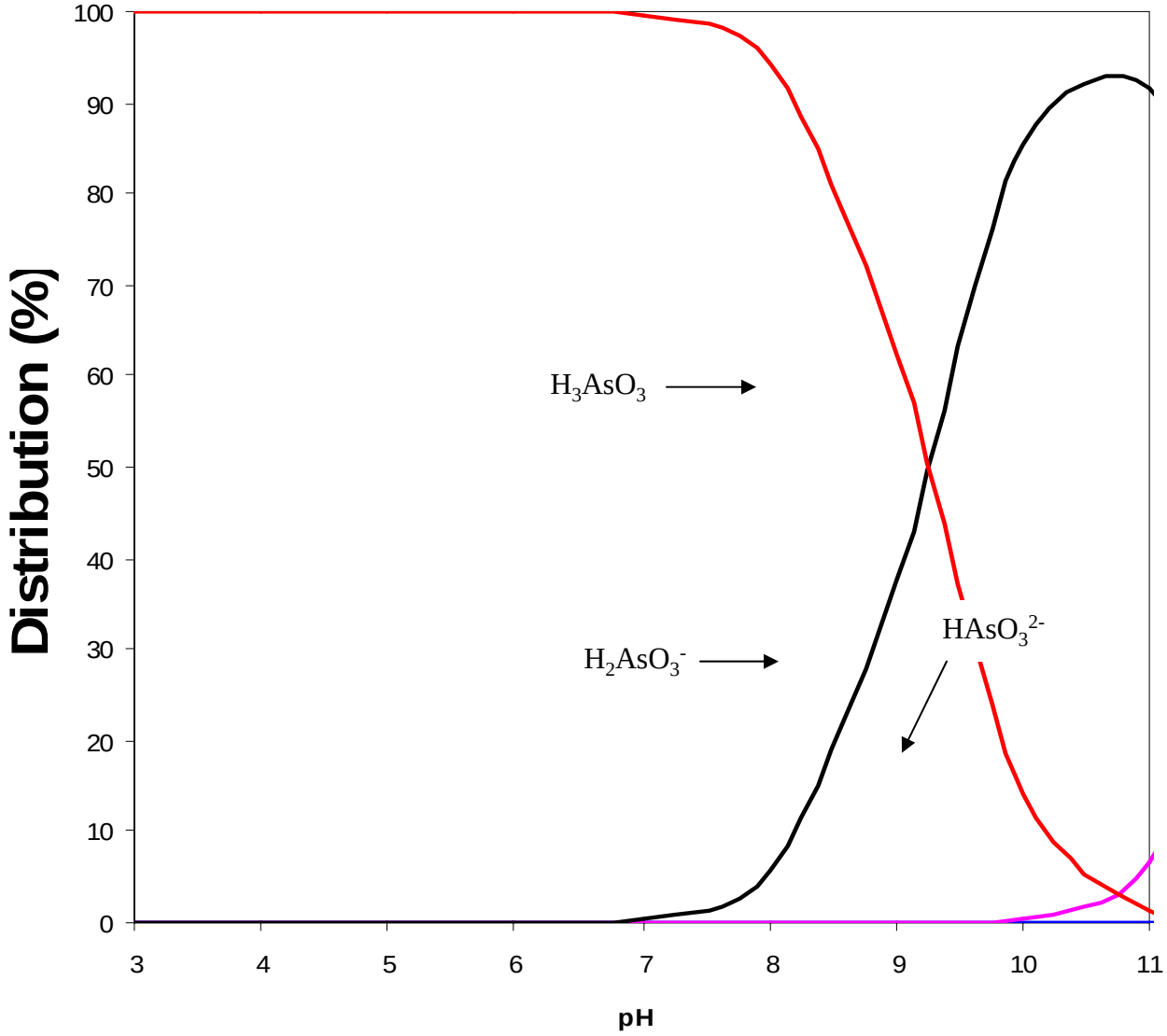

Testing History

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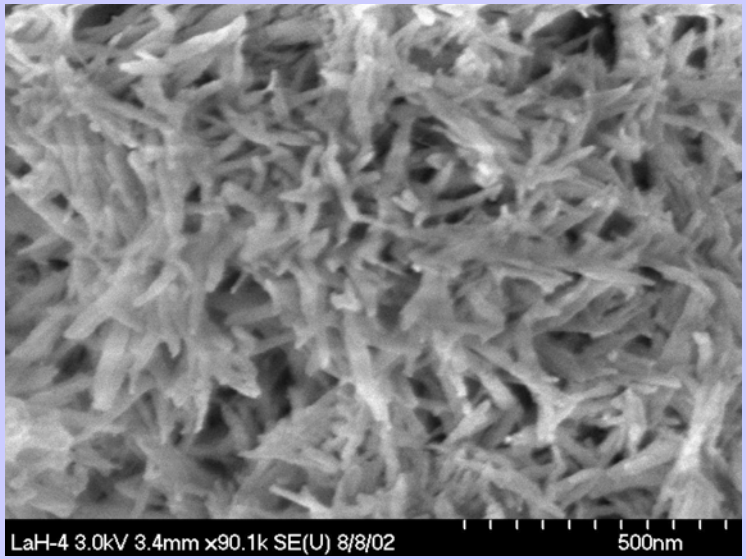
- Batch test
  - Ex-situ and In-situ methods comparison for removing arsenic from synthetic solution
  - Fernley groundwater ex-situ and in-situ methods comparison
- Continuous
  - Pilot scale test performed at Fernley water treatment plant



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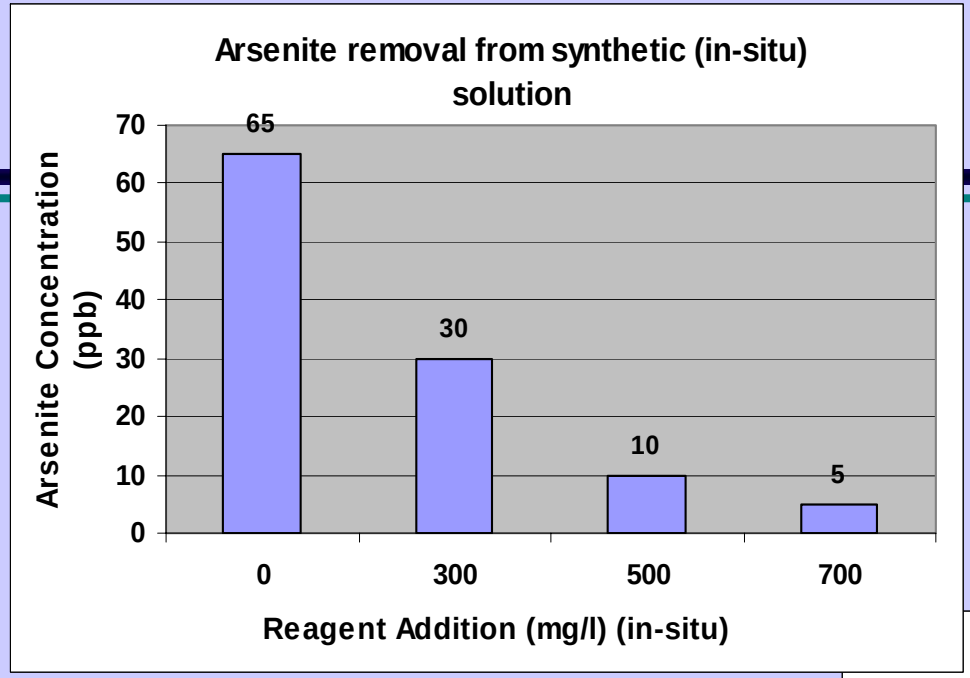
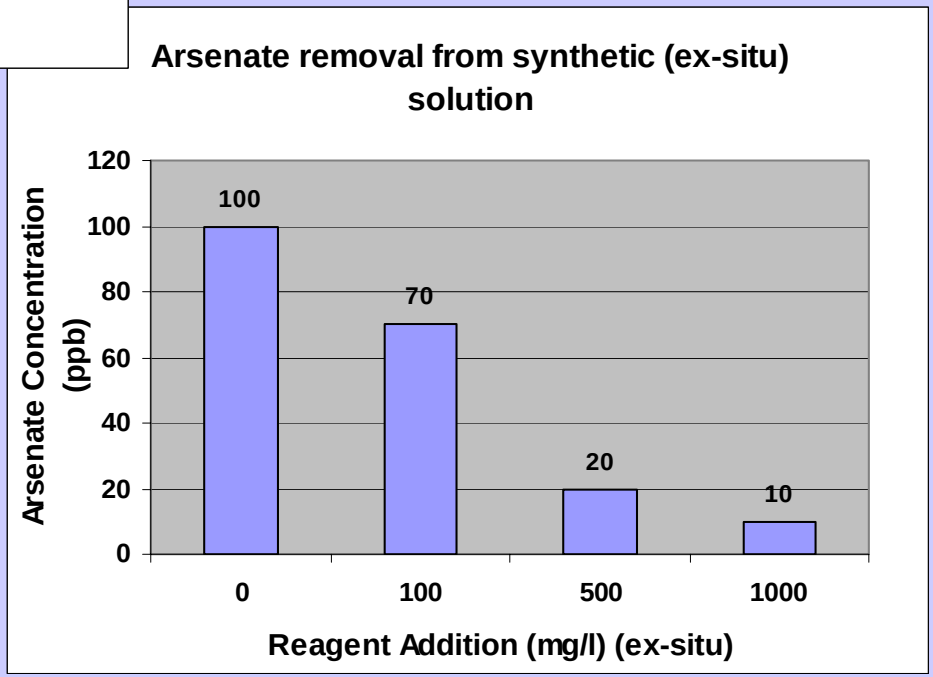


Bench-scale tests showed that both the arsenate and arsenite species can be effectively removed from drinking water using hydroxy crystals coated onto DE



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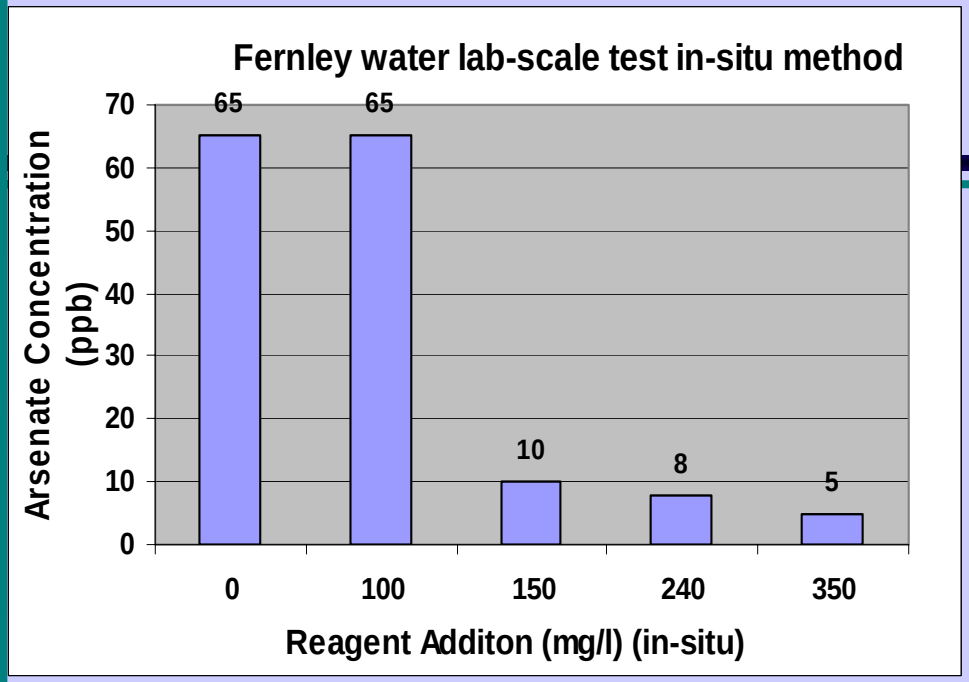
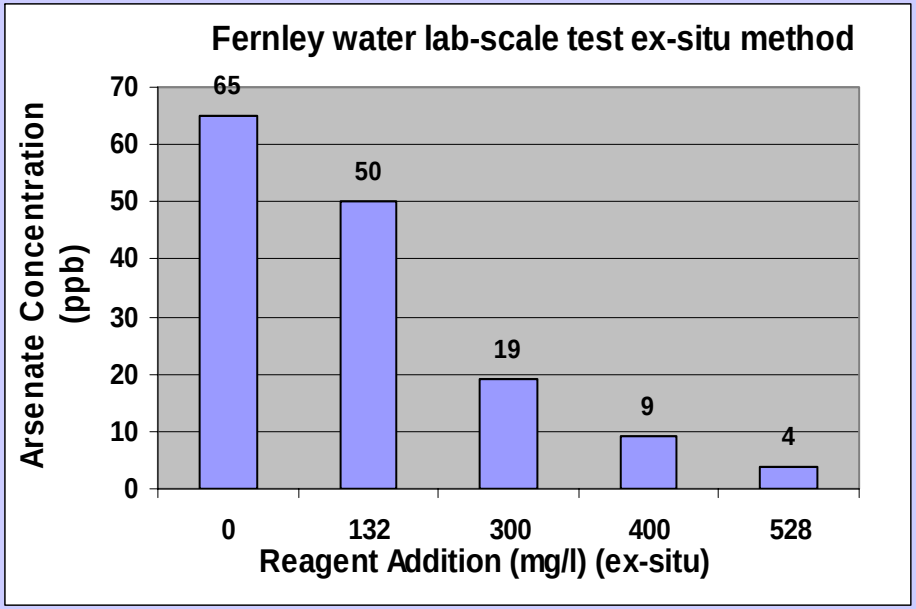


The material prepared by the in-situ
method is invariably more effective
than ex-situ method



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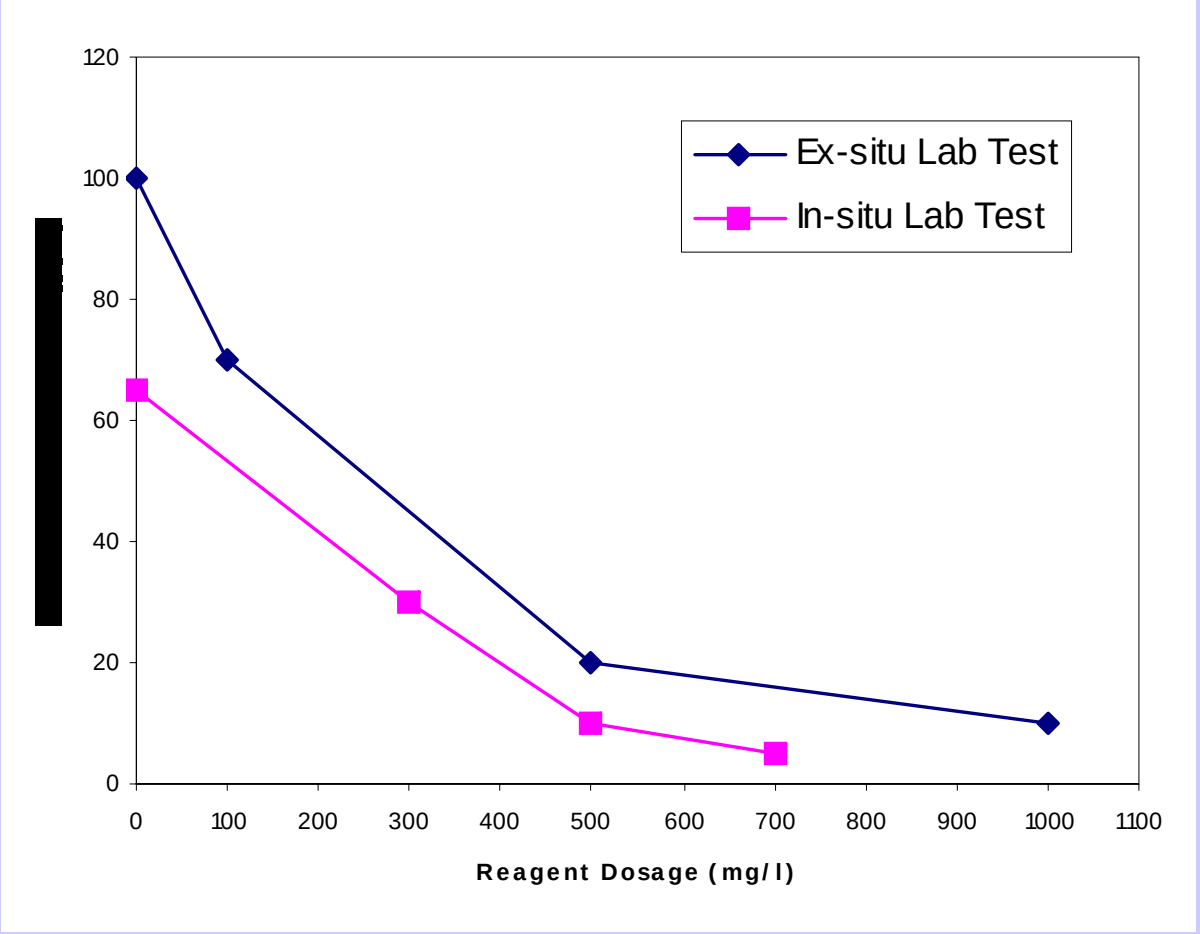
Arsenic Removal from Synthetic Solution

(Continuous Test)



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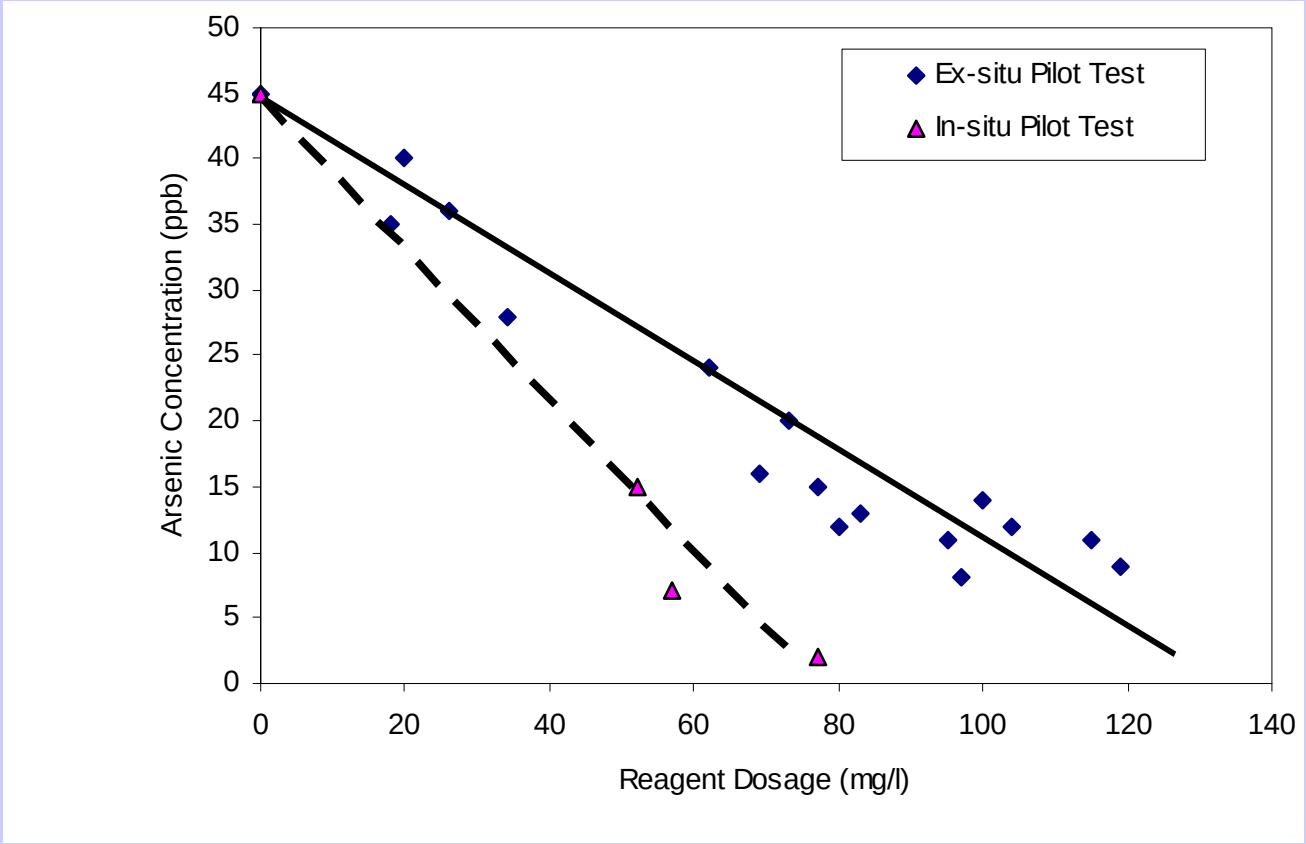
Arsenic Removal from Fernley Well Water
(Pilot Test)



Pilot Test Results

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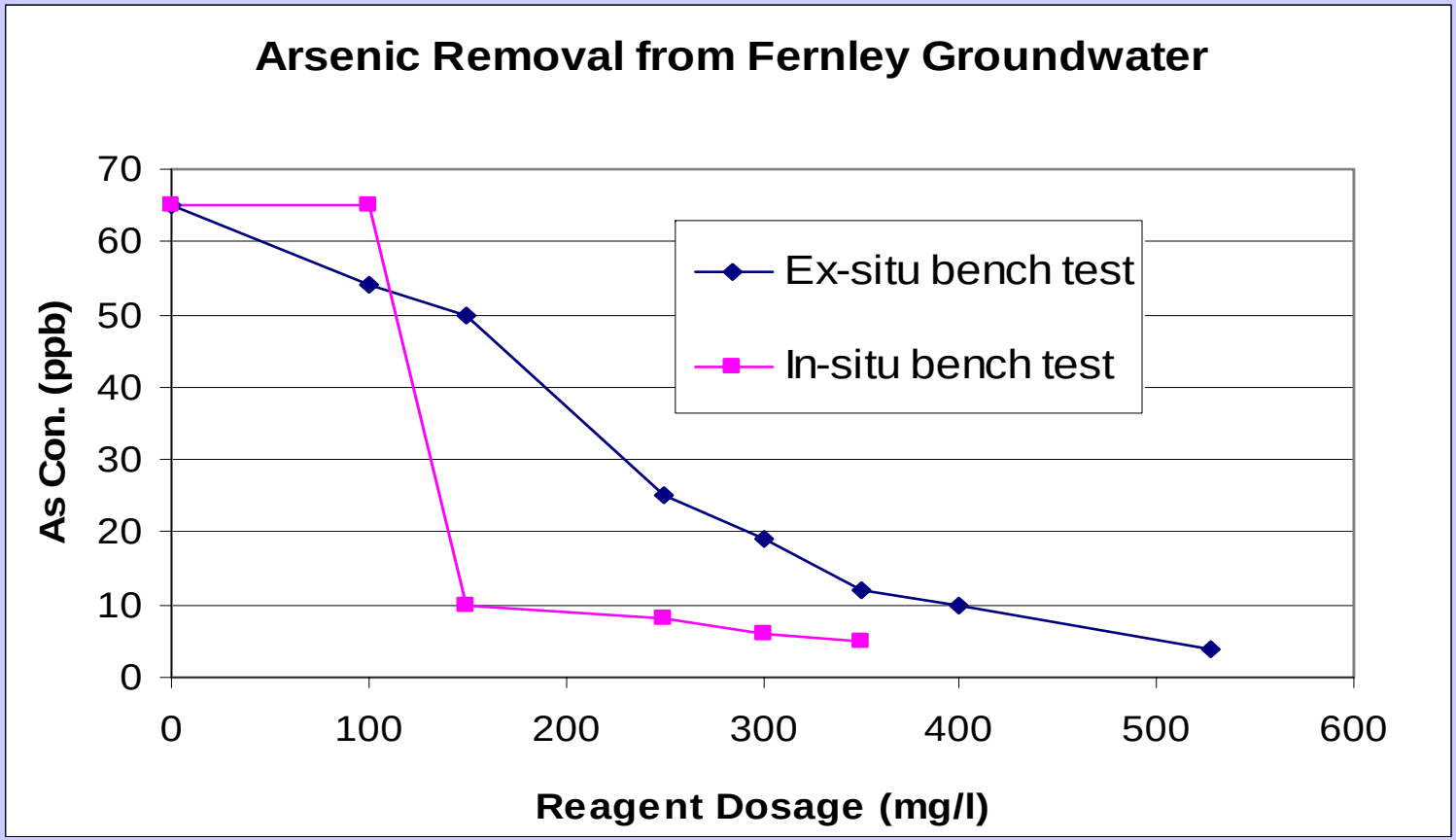

- The material prepared by the in-situ method is invariable more effective than ex-situ method
- Fernley water 43-57 ppb As

Pilot Site – Fernley, NV

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Operated at a flow rate of 12-15 gallons/min.

DE Precoat Filtration
Fernley, Nevada Pilot Method

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- DE filtration is a two-step operation. In the "precoating" operation, a thin layer of clean filter aid is coated on the filter element by recalculating a dilute slurry of filter aid through the filter.
- A small amount of filter aid is continually added to the liquid being filtered. As the filter cycle progresses, the bodyfeed produces a fresh new filtering surface to entrap particles and also provides microscopic channels through which the clarified fluid can flow.

Summary of Pre-coat Filtration Technology

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- De coated hydroxide in conjunction with pre-coat filtration has demonstrated potential for the treatment of arsenic in well waters
- This method is cost effective and efficient in meeting the proposed Federal drinking water limits of 10 ppb arsenic
- Bench-scale and pilot test have established that the arsenic treatment cost is estimated to be $0.30-0.40 per 1000 gallons
- The process is effective in removing arsenite and arsenate within a pH range of 6.5-8.5
- The arsenic containing DE sludge after treatment meets TCLP standards for disposal

La-DE and/or La-Fe-De Adsorption Process

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- Based on the bench and pilot test results, EaglePicher believes the fundamental principle for arsenic removal by DE-La or DE-La-Fe precoat filtration technology can be applied to adsorption as well.
- EaglePicher has conducted RSSCT with La-DE and currently performing another RSSCT with La-Fe-DE for removing arsenic from drinking water

Adsorption Testing

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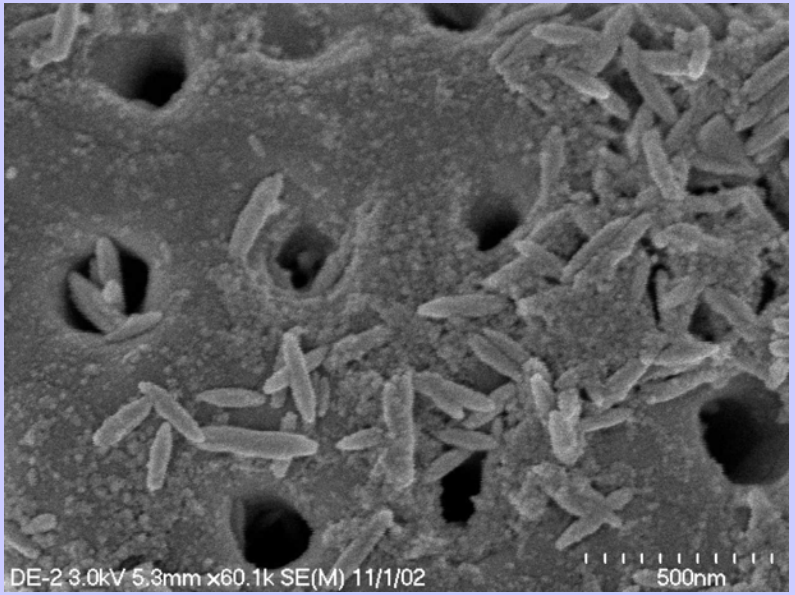
- Bench testing
  - Screening adsorbent based on DE size for RSSCT

    Rapid small scale column testing (RSSCT)
    - La-DE
    - RSSCT using La/Fe-DE material is in progress

SEM Picture of La/Fe/De (300°C)



Adsorption Bench Results

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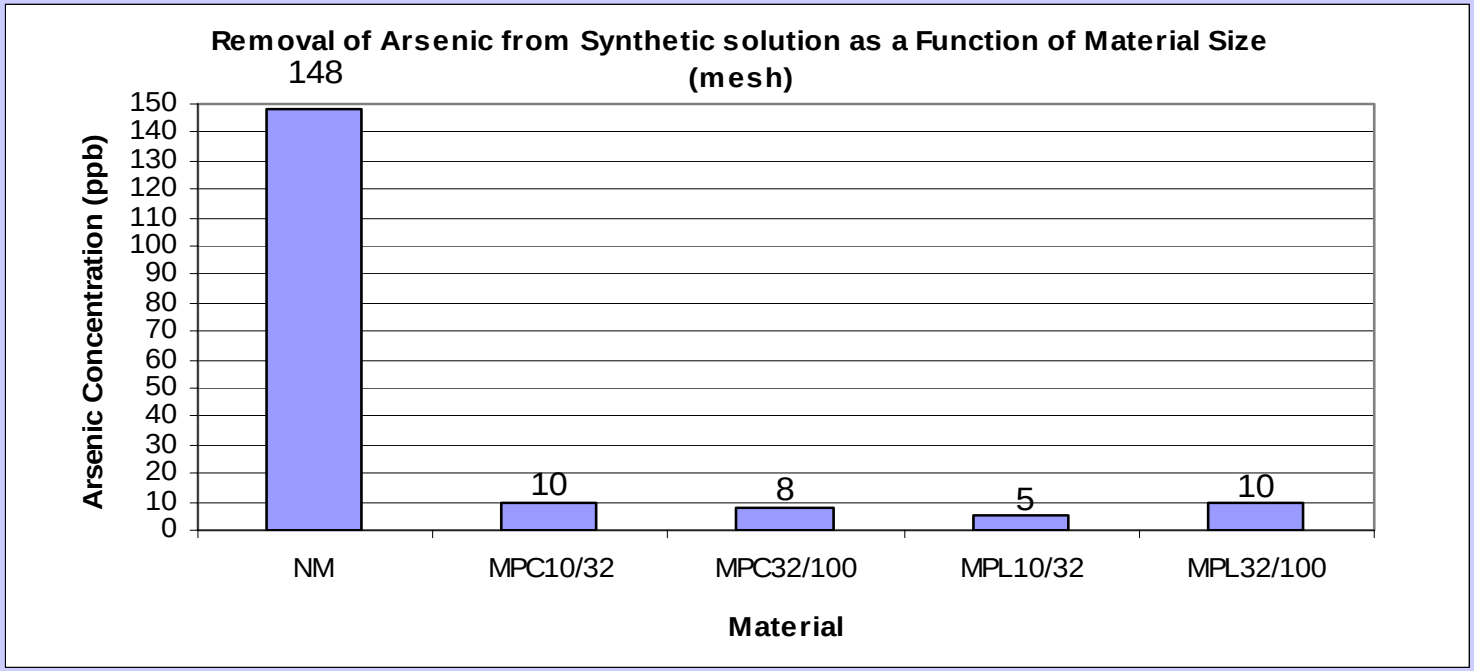

- **MPC32/100 & MPL10/32 have been selected for RSSCT**
  - **MPC32/100 is Lanthanum-Iron Enhanced 150-450 microns DE Nanocrystalline media**
  - **MPL10/32 is Lanthanum Enhanced 500-710 microns DE Nanocrystalline media**

La-DE POU Test

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- Test conditions:
  - Arsenic species in water: As^{+3}
  - Arsenic Concentration: 100 ppb
  - pH of water: 7.2
  - Surface area of adsorbent: 101 m^2/gm
  - Bed volume: 100 cc
  - Flowrate: 100 cc/min
  - EBCT: 60 sec

Test Results – To Date

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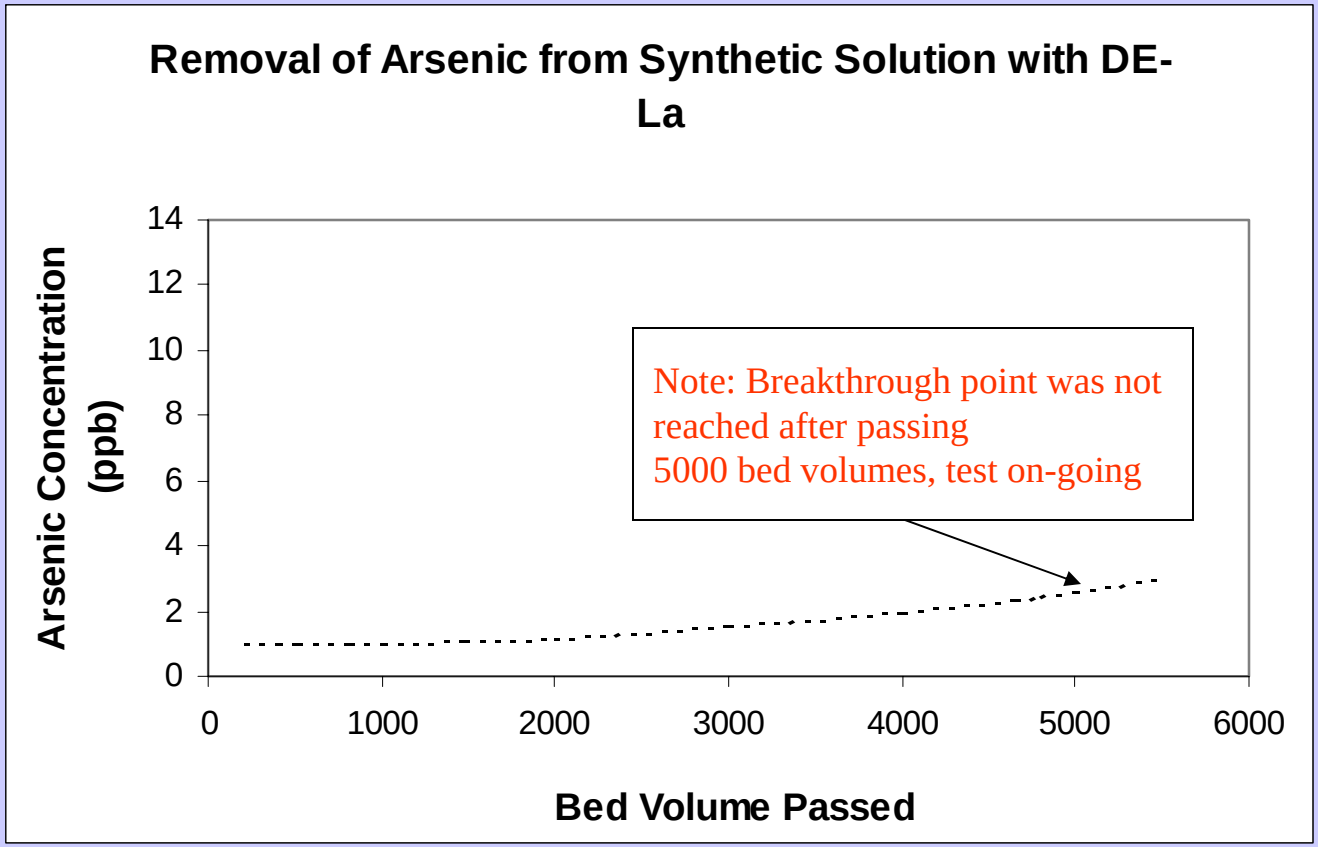

Initial Testing Looks Promising

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Thank You